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THE MARINE BIOLOGICAL LABORATORY.

BY

PROFESSOR E. G. CONKLIN.

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THE MARINE BIOLOGICAL LABORATORY.

THE twelfth annual session of the Marine Biological Laboratory at Woods Holl, Mass., which was held during the past summer, was lacking in none of the elements of interest and success which have made former sessions notable, while several new and valuable features were added last year for the first time. In addition to the regular courses of instruction in Zoology, Embryology and Botany, there was given last year, under the direction of Professor Loeb, a course on Comparative Physiology. Such a course can be given advantageously only at the seashore where living animals of all classes may be had in abundance. In the organization of this course the Woods Holl Laboratory has taken a unique and advanced position which cannot fail to yield valuable results not only to research but also to physiological instruction throughout the country. Another notable feature was the course of lectures and demonstrations in Comparative Psychology given by Dr. Thorndike. This course was followed with the keenest interest by a large number of persons at Woods Holl. The general lectures, a volume of which is published annually, were unusually numerous and valuable. The facilities for dredging in deep water and for making extensive collecting trips were never before so good, thanks to the courtesies of the Fish Commission Station. The United States Fish Commission steamer, *Fishhawk* and schooner *Grampus*, were stationed at Woods Holl and they, with the smaller vessels of the Commission and of the Marine Biological Laboratory, formed a fleet of vessels equipped for scientific work such as has rarely assembled in one place before.

The attendance at the Laboratory was gratifyingly large; there were seventy-one investigators and seventy-eight students, representing sixty-nine different schools, colleges and universities. When it is remembered that there were last year three other marine laboratories on our Atlantic coast, offering their facilities freely, or for much less than the fee at the Marine Biological Laboratory, there is all the more reason for satisfaction at the large number in attendance. In the character and variety of the research work done the past season was not excelled by any preceding one, and in some respects it surpassed them all.

All these features show that the Marine Biological Laboratory is to-day, as much as at any time in its past history, the center of biological instruction and investigation in this country. This can still be said in spite of the fact that there are numerous other marine and fresh water stations in this country, which are doing excellent work and are worthy of generous praise and support. However, no other American station has the national and even cosmopolitan character of the Woods Holl Laboratory; no other enjoys the coöperation of so large a number of educational and scientific institutions, no where else is the whole field of biology so fully represented and no other

Ameriean laboratory is so produetive in original work, nor has so large a number of investigators and students.

The Marine Biologieal Laboratory is a shining illustration of the faet that men and not buildings nor material equipment make an institution great. There is probably no other edueational or seientific institution in the world whieh on so small a financial basis has aecomplished so great a work. This work is of such seientifie and edueational value and the Laboratory stands for so fine an ideal of seientific eoöperation that a brief aeeount of its history and work should not be wholly laeking in interest or suggestiveness.

The Laboratory can claim to be a lineal deseendant of the first marine laboratory in Ameriea, the sehool established by Louis Agassiz in 1873, on the island of Penikese, in Buzzards Bay. The Penikese Laboratory was abandoned in 1874 at the close of its seeond session, after having reeeived in buildings, equipment and endowment, more money than has been given to the Marine Biological Laboratory during the twelve years of its history. This step was made neeessary on aeeount of the unfortunate loeation of the laboratory on an isolated island, and above all by the death of the man whose genius had ereated it and who alone was able to seeure the scientific coöperation neeessary to its maintenance. After the elosure of the Penikese Laboratory an attempt was made to seeure the eoöperation of educational and seientifie institutions in establishing a marine laboratory at Woods Holl, but the support was not fortheoming at that time and the projeet was abandoned.

In 1880 the Woman's Edueational Assoeiation of Boston, aeting in eoöperation with the Boston Soeiety of Natural History, opened a seaside laboratory at Annisquam, Mass., and this eontinued in operation for six years. In 1886 the supporters of that laboratory addressed a eireular letter to many leading biologists in this eountry asking their coöperation in the work of establishing the laboratory on a broader basis.

Fig. 1. Main Building, Marine Biological Laboratory.

In Mareh, 1887, a meeting of persons interested in the enterprise was held in Boston, and a committee was appointed "to perfeet plans for the organization of a permanent seaside laboratory, to eleet trustees and to devise ways and means for eolleeting the

necessary funds." In the spring of 1888 about ten thousand dollars had been secured, and accordingly the Marine Biological Laboratory was incorporated and steps were taken to open it that season. After prolonged consideration the trustees decided to locate the laboratory at Woods Holl, Mass., and the whole history of the institution has shown the wisdom of this decision.

The natural advantages of Woods Holl deserve especial emphasis because they have been fundamental to the success of the Laboratory. In a good location a biological laboratory may be highly successful with very little equipment, while in a poor location no amount of money can make up for this defect.

In 1881 Professor Baird determined to locate the marine laboratory of the U. S. Fish Commission at Woods Holl, after having investigated, during the preceding ten years, almost every available point on the Atlantic coast. It is doubtful whether at any other single place on this coast so many valuable and important features can be found. The only other place seriously considered by Professor Baird was Newport, R. I., and this was finally rejected because of the relative impurity of the water of Narragansett Bay. On the other hand the waters of Buzzards Bay and Vineyard Sound are of exceptional purity, there being no large fresh water streams in the vicinity nor cities discharging their filth into the waters. In the immediate vicinity of Woods Holl are numerous harbors and lagoons, with muddy, sandy or rocky bottoms, while the coast is so broken by bays, promontories, straits and islands as to afford the most varied habitats. In addition the tide currents which sweep in through the sound and 'hole' bring in multitudes of floating animals and plants, many of which are tropical forms carried in from the Gulf Stream, which is distant only about one hundred miles. The proximity of the Gulf Stream to this portion of the New England coast gives a laboratory located at this point many of the advantages of a tropical station without any of the accompanying disadvantages. There are also many fresh water ponds and lakes in the vicinity which contain a rich fauna and flora. Add to these things the fact that Woods Holl is readily accessible by rail or boat, that the climate in summer is delightful, the bathing excellent, the mainland and islands charming, the sound with its continual procession of ships always varied and interesting, and you have in Woods Holl not only an ideal place for a laboratory, but also an ideal place for summer residence.

Having determined to locate the Laboratory at Woods Holl, the Trustees bought a small piece of land near the Fish Commission Station and erected upon it a plain wooden building, 63 x 28 feet and two stories high. This was equipped with the most necessary apparatus and the Marine Biological Laboratory was first opened July 17, 1888.

From the first it was determined that the Laboratory should not be under the control of any college, university or other institution, but that it should be truly national in character and that it should invite the coöperation of all persons and institutions interested in the advancement of the science of Biology. Accordingly the Laboratory was organized on an independent foundation.

Its government was vested in a Corporation and a Board of Trustees. The Corporation, at first ten in number, now consists of several hundred persons, many of them present or former students and investigators at the Laboratory, who are interested in its welfare and have contributed to its support. The Corporation elects annually six members of the Board of Trus-

tees, passes upon all proposed changes in the Constitution and By-Laws, hears an annual report from the Director and the Treasurer and makes such recommendations concerning the general policy of the Laboratory as it may desire. The Board of Trustees, at first seven in number, now consists of twenty-seven members, some of them business men of recognized ability, but most of them biologists representing prominent educational institutions in almost every part of the United States and Canada. The Board has direct charge of the property and funds of the Laboratory, elects the Director and Assistant Director, and has general supervision of the scientific work.

From the first the institution has been under the directorship of Professor C. O. Whitman, and it is but simple justice to say that the remarkable success which has attended it is due in large measure to the high ideals and the untiring energy and sacrifice of Professor Whitman. For twelve years he has devoted himself to the Laboratory without compensation and with an enthusiasm which has served to inspire many others with his own ideals concerning the Laboratory and to enlist their hearty coöperation.

In his address at the opening of the Laboratory and in subsequent publications, Professor Whitman took the position that there was great need for a laboratory which should represent, (1) the whole of biology; (2) both teaching and research; (3) the widest possible coöperation of educational and scientific institutions. Such a laboratory should not be merely a collecting station, nor a summer school, nor a scientific work shop, nor a congress of biologists, but all of these; an institution combining in itself the functions and features of the best biological institutes of the world, having the coöperation of the biologists of this country, and thus forming "a national center of instruction and research in every department of Biology." The history of the Laboratory has shown that this ambitions project is not only highly desirable, but that it is entirely feasible and has justified the claim of the Director that such an institution is the greatest need of American biology.

"The new laboratory at Woods Holl," said the director in his first report, "is nothing more and I trust nothing less than a first step toward the establishment of an ideal biological station, organized on a basis broad enough to represent all important features of the several types of laboratories hitherto known in Europe and America. * * * An undertaking of such magnitude cannot be a matter of local interest merely, and if it be pushed with energy and wisdom, it cannot fail to receive the support of the universities, colleges and schools of the country." There was little in the early conditions of the laboratory to justify such high hopes. It began with no assured cooperation, no constituency, a bare building, no library, no private rooms for investigators, only a row boat for collecting and with only two instructors, seven investigators and eight students.

Since that time the growth of the laboratory in material equipment has been encouraging, while its growth in numbers and in the scope and volume of scientific work has been phenomenal. During the second season $1000 was given to establish the Glendower Evans Library; $2500 was raised in Boston to establish two scholarships at the laboratory as a memorial to Lucretia Crocker, long a supervisor in the public schools of Boston. During the third season a lecture hall and library room were constructed as an addition to the building and the 'Gifford Homestead,' together with about one-half acre of land adjoining the Fish Commission was purchased, the house being converted into a dining hall; a steam launch was also

seenred. In the fifth ycar an additional laboratory of the size of the original building was construeted. In the seventh year a new laboratory was built for botany and a large dining hall was ereeted, capable of aeeommodating two hundred people at one time. In the ninth year a building eontaining a large lecture hall and researeh laboratories was eonstrueted and a two-masted sehooner was added to the fleet of eollecting boats.

Although this growth in material equipment has been rapid, the needs of the laboratory have grown still more rapidly. The bnildings are all of a temporary charaeter and can be used only in summer; at least one substantial, fire-proof building is needed whieh can be used the year aronnd; the library is inadequate to the needs of sueh aquaria and, although eordial and mutually helpful relations have always existed between the two stations, additional land, with shore privileges, ought to be sceured while it can be had; above all the Laboratory needs increasd endowments both for special purposes, such as scholarships, library, publieations, ete., and also for general maintenanee.

The growth in material equipment, though encouraging, is overshadowed in importance by the growth in the number of persons in attendance at the Laboratory. In 1888 there were nine investigators and eight students representing thirteen different institutions of learning; in 1899 there were seventy one investigators and seventy-eight students representing sixty-nine different institutions. In all during

Fig. 2. Main Building, Botanical Laboratory, Lecture Hall and Research Laboratory.

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among the occasional lecturers and visitors must be numbered almost all the better known biologists of this country and many from foreign lands.

As the outgrowth of a summer school it might have been expected that the laboratory would give instruction in biological subjects, and at its very beginning its founders resolved that it should also give opportunity for original research. The combination of these two functions at the Laboratory has been a peculiarly fortunate one. It has been proved, not only here, but also in many universities and scientific institutions, that research and teaching are of mutual service. A certain amount of teaching is stimulating to the investigator, while the atmosphere of research is indispensable to good teaching.

When the Laboratory was first established instruction was given in Zoology only, since then courses have been added in Botany, Embryology, Physiology and it is understood that Comparative Psychology and Nature Study will form a part of the regular program hereafter. In these courses there is an earnestness and enthusiasm on the part of students and instructors which is highly stimulating. This is due not only to the exceptional character of the students and instructors, but also to the atmosphere of investigation which prevades the place and which is one of the most helpful features to the beginner, as well as to the advanced worker. Instruction includes not only ordinary laboratory work in the subject named, but also a great deal of observation and collection of living organisms in their natural haunts. Collecting trips and excursions form a regular part of the work, and a most important and enjoyable part. Investigators and even visitors at the Laboratory cheerfully contribute to the work of instruction, and so it generally happens that the lectures are given by men who are specialists in the subjects under consideration and who are able to teach with the enthusiasm, accuracy and directness of 'those having authority.' When it is remembered that the persons in attendance at the laboratory are almost without exception teachers, the tremendous influence of the Laboratory on the teaching of Biology in the schools, colleges and universities of this country can be surmised.

Fig. 3. Fish Commission Buildings, Wharf and Steamer; one of the Marine Biological Laboratory Buildings on the right.

In 1891 a Supply Department was opened at the Laboratory for the purpose of furnishing to schools and scientific institutions various kinds of biological material to be found in the vicinity of Woods Holl. The

collectors studied the best methods of preserving material, the habitats and breeding seasons of various animals, etc., with the result that the Supply Department has been not only a great financial assistance to the Laboratory, but that it has still further contributed to the scientific purposes for which the Laboratory was established. At present a skilled collector is employed the year around and material is gathered, not only from the vicinity of Woods Holl, but from far distant points.

FIG. 4. A Collecting Trip; Launch and Schooner in the Background.

But it is in the work of investigation that the Laboratory has won greatest renown. The eminent scientific standing of the Director and his co-laborers has served to attract investigators from all parts of the land, until the Woods Holl Laboratory is to-day the Mecca of American biologists and is well and favorably known throughout the world. The list of original contributions which have proceeded from the Laboratory during the past twelve years numbers about three hundred; many of these are large monographs, illustrated with numerous colored plates, and some of them represent unique lines of research. For example, the study of 'cell-lineage,' as it has been called, had its origin at the Woods Holl Laboratory and has so far been confined almost entirely to that institution. This work consists in tracing the cleavage cells, into which the developing eggs of all animals divide, through the whole development until they give rise to larval or adult organs, such as the brain, nerves, sense organs, glands, alimentary canal, etc. This is in all cases a difficult task, frequently taking years of the most painstaking labor, but its results have been of fundamental and far reaching importance. Thanks to this work we now know the cell-lineage of about a score of worms and mollusks. This work has shown that from their first appearance certain cleavage cells are destined to give rise to certain organs; it has shown that, in the groups mentioned, cleavage is as constant in its character as are adult features; that in animals so widely separated as flat-worms, annelids and mol-

lusks these early divisions of the egg are almost identical and that many corresponding cleavage cells give rise to homologous organs. Incidentally such work has shown the close genetic relationship of the groups named ; it has also set a new pace in embryology. Now that we know the exact cell origin of these layers and organs, it will never again be possible in describing the development of these animals to refer the origin of certain organs to 'germ layers' merely, nor to refer the origin of these layers to certain general regions of the embryo. The importance of this line of work, not only in the study of the groups named, but also to the science of embryology as a whole, is fully recognized both in this country and abroad, and the credit for this service belongs in large part to the Woods Holl Laboratory.

Other work of the greatest importance has been done in the line of what has been called 'physiological morphology.' It would exceed the limits of this article to give even a brief description of papers of this class which have issued from the Laboratory. A few of the more striking lines of work, however, must be mentioned. Much attention has been given to experiments on the regeneration of lost parts in various animals. In hydroids, sea-anemones and worms these parts are sometimes reproduced in a normal manner, while under different conditions a head may be caused to develop where a tail belongs or *vice versa*. Another line of work has been the grafting together of different parts of animals. One member of the Laboratory succeeded in grafting together in almost every possible manner the pupæ of different moths and butterflies. Some of these afterwards went through the metamorphosis and came out as 'Siamese twins,' 'tandems' with four wings, etc. Another line of work, even more important, is found in 'experimental embryology.' In one famous experiment performed at the Laboratory, the eggs of the sea-urchin were artificially fragmented before they began their development, and in this way twins, triplets, or still more numerous larvæ might be produced from a single egg. If the fragments of the egg were entirely separate, the larvæ which developed were separate and perfect, if they were united, the larvæ were united forming all kinds of double or multiple monsters. Other experiments have shown that certain salt solutions will cause unfertilized eggs to develop for a short time in an irregular way, and only last summer Professor Loeb discovered that he could cause the unfertilized eggs of the sea-urchin to develop into normal larvæ, in short, could produce artificial parthenogenesis in a phylum in which it has never before been known, by treating them with certain salt solutions ; this is certainly one of the most remarkable biological discoveries of recent years. The lines of work outlined above, together with many which could not here be mentioned, and which have been actively prosecuted at the Woods Holl Laboratory, have been substantial contributions toward the solution of some of the most fundamental problems of biology.

Each year a course of general lectures on various phases of biological work is given by different members of the Laboratory and by distinguished visitors. These lectures are usually brief accounts of important investigations, presented in a popular form. A volume of these lectures is published annually and the contents of the volumes form a brief index to the multifarious activities of the Laboratory in research. These volumes are not only important contributions to knowledge, but still more, they are brief and popular presentations of what are often abstruse and difficult subjects, and as such they appeal strongly to investigators, teachers and general readers who

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Although this growth in material equipment has been rapid, the needs of the laboratory have grown still more rapidly. The buildings are all of a temporary character and can be used only in summer; at least one substantial, fire-proof building is needed which can be used the year around; the library is inadequate to the needs of such an institution; the facilities for collecting should be enlarged and increased; the Laboratory is entirely dependent upon the Fish Commission Station for wharf privileges and for pumping sea water to its aquaria and, although cordial and mutually helpful relations have always existed between the two stations, additional land, with shore privileges, ought to be secured while it can be had; above all the Laboratory needs increased endowments both for special purposes, such as scholarships, library, publications, etc., and also for general maintenance.

The growth in material equipment, though encouraging, is overshadowed in importance by the growth in the number of persons in attendance at the Laboratory. In 1888 there were nine investigators and eight students representing thirteen different institutions of learning; in 1899 there were seventy one investigators and seventy-eight students representing sixty-nine different institutions. In all during the twelve sessions there have been in attendance five hundred and ten investigators and seven hundred and forty-five students from nearly three hundred different educational and scientific institutions, while

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have not the time to go more fully into these subjects. As showing the opinion of the outside world with regard to these lectures, the following is quoted from *Natural Science*, December, 1899: "Every biologist who is still young enough to be enthusiastic, looks with eagerness about this time of year for the arrival of the volume of 'Biological Lectures' from the Marine Biological Laboratory, Woods Holl, Mass. * * * One cannot help feeling that the intellectual atmosphere of Woods Holl must be bracing, the lectures are so vigorous. The charm of these lectures may be partly due to the circumstances of their delivery, but it is doubtless mainly due to the fact that each is an expression of personal work and personal interest. One cannot but be grateful to the Laboratory at Woods Holl, which has been the stimulus of the fine series to which this volume is added, *Florcat Woods Holl.*" In addition to the volume of lectures there is also published under the auspices of the Laboratory the *Biological Bulletin*, as well as the Annual Reports and Announcements.

The service which the Laboratory has rendered to biological instruction in our schools and colleges and to advanced work in biology in general is incalculable; it is the biological clearing house of this country, where the specialist who has been unable to keep up with the general advance of his science may learn from others what has been transpiring in fields outside his own, where teachers may exchange ideas as to the best methods of instruction, where distinguished men in various fields come to know each other in the most intimate and helpful way, and where all may get broader and truer ideas of the great problems of biology. The Laboratory is also a place to which schools, colleges and universities are coming to look for good men. This feature has never before been emphasized and it receives no direct attention at Woods Hall, but if the indirect influence of the Laboratory in discovering good men and placing them in good positions were known, it would be seen that this feature is no small part of the service which the Marine Biological Laboratory renders to American biology.

The confidence of the Director that the Laboratory would not fail to receive the support of the schools, colleges and universities of the country has been fully justified. During the past twelve years representatives from about three hundred schools and higher institutions of learning have been in attendance at the Laboratory, while twenty-seven colleges and universities and three societies have been regular subscribers to Rooms and Tables. The Laboratory has now grown to such proportions that it cannot expect to draw any large part of its financial support from educational institutions, already overburdened. It is itself an educational and scientific institution of highest rank, and however measured, deserves to stand alongside the best scientific schools and laboratories of the world. "It is acknowledged that only one similar institution in the world (Naples) is more productive in original research, and no other offers even approximately equal advantages for instruction." Such an institution deserves and expects independent support.

The present financial condition of the Laboratory is shown by the following figures:

Total Assets.

Estimated value of real estate, buildings and equipment at Woods Holl	$35,000.

Invested Funds.

General Endowment	$ 4,553.
Lucretia Crocker Fund	2,500.
Library Fund	866.
Interest on hand	230.
	$43,149.

Total Liabilities.

Mortgage on Woods Holl property	$2,900.
Unsecured Loans	5,276.
	$8,176.
Assets less Liabilities	$34,937.

The total earnings of the laboratory as compared with its expenses are given herewith. ('Earnings' include all sources of income save donations only; 'expenses' include all disbursements save those for land, buildings and permanent equipment.)

Total Donations	$37,730.
Earnings	$47,919.
Expenses	$50,759.

It appears from this statement that the income of the Laboratory, like that of scientific and educational institutions in general, is scarcely sufficient to meet the running expenses, and that it must look to the donations of interested friends for assistance in meeting a small annual deficit and for all permanent equipment and enlargement. This is a fact which requires no apology; the Laboratory is not a commercial enterprise but a charitable institution, in the same sense that colleges and universities are such. It is not the purpose of the Laboratory to make money, but rather to contribute as much as possible to the advancement of science, and in this respect it has fulfilled the highest hopes of all its friends. There is every reason to be proud of the fact that it has accomplished so great a work on so small a financial basis, and that it is at present so nearly self-supporting as it is.

The Trustees at their meeting in New Haven, December 29th last, resolved that for the best interests of the Laboratory the out-standing debt of $8,176, should be paid off at once and that a small cash balance should be left in the hands of the Treasurer. They, therefore, appeal to the friends of the Laboratory to contribute $10,000 to this end. Subscriptions may be sent to the Treasurer, D. Blakely Hoar, 220 Devonshire Street, Boston, or to any member of the Board of Trustees.

The time has come also when to give the Laboratory the stable and permanent character which it deserves it should be liberally endowed. Where could a better investment be made than in a scientific and educational institution with such a history behind it and such excellent prospects before? The Laboratory and the ideals for which it stands must not be allowed to suffer for lack of support; it must not remain standing where it is, for although its success has been remarkable, it is only the beginning of what it should and could do, if properly supported. The aim of those who are interested in its welfare is to create a permanent station with adequate endowment and equipment which shall be in the future yet more than in the past 'a national center of research in every department of Biology.'

For this end its friends labor and wait, hoping that the time is not far distant when generous friends of science and education will see its needs and its opportunities and will not be slow in their response.

E. G. Conklin.

University of Pennsylvania.

DIGEST OF THE

LIBRARY REGULATIONS.

No book shall be taken from the Library without the record of the Librarian.

No person shall be allowed to retain more than five volumes at any one time, unless by special vote of the Council.

Books may be kept out one calendar month; no longer without renewal, and renewal may not be granted more than twice.

A fine of five cents per day incurred for every volume not returned within the time specified by the rules.

The Librarian may demand the return of a book after the expiration of ten days from the date of borrowing.

Certain books, so designated, cannot be taken from the Library without special permission.

All books must be returned at least two weeks previous to the Annual Meeting.

Persons are responsible for all injury or loss of books charged to their name.